European Railway Agency

INTEROPERABILITY UNIT

REVISION OF THE WAGON TSI

TRANS-EUROPEAN CONVENTIONAL RAIL SYSTEM

SUBSYSTEM ROLLING STOCK

TSI "WAGON"

Reference:	IU-WAG TSI- Preliminary draft 1.0.doc	**Document type**:	Technical specifications for Interoperability
Version :	Preliminary draft 1.0	**Status :**	DRAFT
Date :	31 January 2011		

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Legenda:

Text in yellow: references, links, etc. To be verified

AMENDMENT RECORD

Version	Date	Chapter number	Modification/description	Author
~~0.1~~	~~11/12/08~~	~~All~~	~~Creation~~	~~SH~~
~~0.2~~	~~21/1/09~~	~~4.2.4 + 7.7.2.2.6.3~~	~~WP Meeting N°14+SG Braking M6~~	~~SH~~
~~0.2.3~~	~~20/3/2009~~	~~4.2.2 + 4.2.6+ 4.2.8~~	~~WP Meeting N°16 + SG Buffer and Draw Gear~~	~~DB~~
~~0.2.4~~	~~08/04/2009~~	~~4.2.2~~		~~DB~~
~~0.2.5~~	~~30/9/2009~~		~~WP Meeting 18 +20+ 21~~	~~SH~~
~~0.2.6~~	~~30/11/2009~~	~~Clause 1 &,2~~ ~~Claues 4.2.2 +4.2.4~~	~~Preparatory for WP Meeting 23~~	~~SH-MA-DB~~
~~0.2.7~~	~~02/12/2009~~	~~All up to 4.2 incl.~~		~~DB, MA, SH, AS~~
~~0.2.8~~	~~08/01/2010~~	~~2.4; 4.2; 5.1; 5.3; 6.1~~	~~Amended following WP meeting n°23~~	~~DB, MA, AS~~
~~0.2.8 amended~~	~~26/01/2010~~	~~Amended during WP meeting n°24~~		~~DB, AS, TG~~
~~0.2.9~~	~~04/02/2010~~	~~Amended following WP meeting n°24~~		~~AS, GT~~
~~0.2.9 amended~~	~~26/02/2010~~	~~Amended following comments received by WP and ERA proposal~~		~~AS, GT~~
~~0.2.10~~	~~31/03/2010~~	~~Amended following WP meeting n°25, reviewed ERA proposal for chapters 4.2.4, (Braking), 4.2.3.5, (Running Safety), 4.2.6, (System Protection) and 4.2.7 (Documentation for operation and maintenance).~~		~~AS, MA, GT~~
~~0.2.10 amended~~	~~23/04/2010~~	~~Comments by NSA LU, CER, and editorial changes~~		~~AS, MA, GT~~
~~0.2.11~~	~~31/05/2010~~	~~Incorporated results of WP meeting n°26, Review section 4.2, Added sections 4.3, 4.4, 4.5, 4.6, 4.7 and 4.8, Proposal of draft chapter 5, Proposal of draft chapter 6~~		~~AS, MA, GT~~
~~0.2.11 amended~~	~~22/06/2010~~	~~Improvement of wording and text structure in all chapters, proposal of clause on environmental conditions, consideration of comments for WP27~~		~~AS, MA, GT~~
~~0.2.12~~	~~31/07/2010~~	~~General revision, First complete draft~~		~~AS, MA, GT~~
~~0.2.12 amended~~	~~06/09/2010~~	~~Appendix D, Comments for WP 28 incorporated~~		~~AS, MA, GT~~
~~0.2.13~~	~~17/09/2010~~	~~Results of WP28 incorporated, basis for call for specific cases~~		~~AS, MA, GT~~
~~0.2.13 amended~~	~~15/10/2010~~	~~Chapter 6 modified according outcome of CSG meeting 06/10/2010, addition of section 6.4 and Appendix F, Extension of scope in chapters 1, 2 and section 4.1, Section 4.8 deleted, Proposal for clauses 4.2.3.6.5 / 6.2.2.3, Comments of WP members for WP 29 incorporated~~		~~AS, MA, GT~~
~~0.2.13 amended agreed on in WP29~~	~~22/10/2010~~	~~Version directly after the WP meeting 29 including comments on the agreed modification to do for version 0.2.14~~		~~WP29~~
~~0.2.14~~	~~08/11/2010~~	~~Revision of 1.1 "Technical scope", 4.2.3.3.3 Train detection systems based on loop equipment, 6.2.2.5 and Appendix C.14 "Thermal capacity" and 7.2 "Substitution, renewal and upgrading" and editorial improvement of the whole text in particular Appendix B.~~		~~AS, MA~~
Preliminary draft 0.1	26/11/2010	Editorial modifications		AS MA, GT
Preliminary draft 0.2	10/12/2010	Following feedback from DGMOVE, considering comments received from the WP members and CSG, basis for discussions in WP 30		AS, MA, GT
Preliminary draft 0.3	17/12/2010	Version agreed on in WP30. Remarks introduced where additional discussion is needed		WP30
Preliminary draft 1.0	31/01/2011	Modification of clauses 4.2.4.3.3 and 6.2.2.4 "Thermal capacity". Reference to Appendix C in clause 7.1.2 removed.		AS, MA

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1. INTRODUCTION

1.1 TECHNICAL SCOPE

In general a Technical Specification for Interoperability (TSI) is a specification by which a particular subsystem is addressed in order

- to meet the essential requirements and
- to ensure the interoperability

as described in the Directive 2008/57/EC. This TSI concerns the rolling stock subsystem shown in point 1 of Appendix II to the Directive 2008/57/EC and within the rolling stock subsystem this TSI covers freight wagons including vehicles designed to carry lorries. In the following this part of the subsystem is called “wagon”.

The application of this TSI is limited to wagons with a maximum operating speed lower than 190 km/h and which are intended to be operated on networks with a nominal track gauge of 1435 mm, 1520 mm, 1524 mm, 1600 mm and 1668 mm.

1.2 GEOGRAPHICAL SCOPE

The geographical scope of this TSI is the whole rail system, in accordance with Article 1 of Directive 2008/57/EC.

1.3 CONTENT OF THIS TSI

In accordance with Article 5(3) of the Directive, this TSI:

a) indicates its intended scope (chapter 2);

b) lays down essential requirements for the concerned domain and for its interfaces vis-à-vis other subsystems (chapter 3);

c) establishes the functional and technical specifications to be met by the subsystem and its interfaces vis-à-vis other subsystems (chapter 4);

d) determines the interoperability constituents and interfaces which must be covered by European specifications, including European standards, which are necessary to achieve interoperability within the rail system (chapter 5);

e) states, in each case under consideration, which procedures are to be used in order to assess the conformity or the suitability for use of the interoperability constituents on the one hand, or the ‘EC’ verification of the subsystems on the other hand (chapter 6);

f) indicates the strategy for implementing the TSIs (chapter 7);

g) indicates, for the staff concerned, the professional qualifications and health and safety conditions at work required for the operation and maintenance of the above subsystem, as well as for the implementation of this TSI (chapter 4).

In accordance with Article 5(5) of the Directive, provision may be made for specific cases for each TSI. Such provisions are indicated in chapter 7.

As far as possible the assessment procedure for the requirements in section 4.2 are defined in chapter 6. In these cases the text of section 4.2 is referring to the corresponding clauses and sub clauses of chapter 6. If for a particular basic parameter the separation of requirements and assessment procedures is not feasible, no reference is given.

1.4 REFERENCE DOCUMENTS

- CR WAG TSI: published in the Official Journal L344, - Commission Decision 2006/861/EC of 28 July 2006, amended by Commission Decision 2009/107/EC of 23 January 2009.

Legislative measures in force:

- Directive 2008/57/EC,
- Directive 2004/49/EC,
- Conventional Rail Control, command and signalling TSI: Commission Decision 2006/679/EC[1],
- High Speed RST TSI: Commission Decision 2008/232/EC[2],
- High speed Infrastructure TSI: Commission Decision 2008/217/EC[3],
- Accessibility for people with reduced mobility (PRM) TSI: Commission Decision 2008/164/EC[4],
- Safety in Railway Tunnels (SRT) TSI: Commission Decision 2008/163/EC[5],
- Conventional Rail Noise TSI: Commission Decision 2006/66/EC[6],
- Conventional Rail Freight Wagons TSI (CR WAG TSI): Commission Decision 2006/861/EC[7], amended by Commission Decision 2009/107/EC[8],
- Conventional Rail Operation and Traffic Management (OPE) TSI: Commission Decision 2006/920/EC[9], amended by Commission Decision 2009/107/EC[10] and 2010/640/EU,

1 OJ L 284, 28.03.2006, p.1
2 OJ L 84, 26.03.2008, p.132
3 OJ L 6440, 19.03.2008, p.105
4 OJ L 64, 07.03.2008, p.72
5 OJ L 64, 07.03.2008, p.1
6 OJ L 37, 08.02.2006, p.1
7 OJ L 344, 8.12.2006, p.1
8 OJ L 45, 14.02.2009, p.1
9 OJ L 359, 18.12.2006, p.1

- Common Safety Methods (CSM): Commission Regulation (EC) No 352/2009[11].
- Description of modules for conformity assessment: Commission descision 2010/713/EU[12].

Legislative measures under adoption process:

- Conventional Rail Infrastructure TSI (CR INF TSI)
- Conventional Rail Energy TSI (CR ENE TSI)
- Recast of TSI OPE CR
- Commission Decision on ERATV.

Legislative measures under development:

- Telematic application for passengers TSI (TAP-TSI)

[10] OJ L 45, 14.02.2009, p. 1
[11] OJ L 108, 29.04.2009, p.4
[12] OJ L 319, 04.12.2010, p.1

2. SCOPE AND DEFINITION OF SUBSYSTEM

This TSI is applicable to “freight wagons including vehicles designed to carry lorries” of the rail system as referred to in Appendix I section 1.2 and 2.2 and extended according to Appendix I chapter 4 of the Directive 2008/57/EC. In the following this part of the subsystem is called “wagon”.

The other vehicles listed in point 1.2 of Appendix I to the Directive 2008/57/EC, especially mobile railway infrastructure construction and maintenance equipment, are in the scope of TSI “Locomotives and passenger rolling stock” (CR LOC&PAS TSI). Units designed to carry

- motor vehicles with their passengers on board or
- motor vehicles without passengers on board but intended to be integrated in passenger trains (car carriers)

are excluded from the scope of this TSI.

This TSI applies to new, upgraded or renewed wagons intended to be placed in service after the entry into force of this TSI.

The documents necessary for the procedures of maintenance and operation are specified in section 4.4 and 4.5 of this TSI.

The additional optional requirements for units used under certain operative regimes are set out in Appendix C of this TSI.

In the present TSI the following definitions are used:

A **unit** is the generic term used to name the rolling stock. It is subject to the application of this TSI, and therefore subject to the EC verification procedure.

A unit can consist of:

- a **freight wagon** that can be operated separately, featuring an individual frame mounted on its own set of wheels or
- a rake of permanently connected **elements**, those elements cannot be operated separately or
- **separate rail bogies** connected to a compatible road vehicle the combination of which form a rake of a rail compatible system.

3. ESSENTIAL REQUIREMENTS

Article 4(1) of the Directive 2008/57/EC states that the rail system, its subsystems and their interoperability constituents shall fulfil the essential requirements set out in general terms in Appendix III of the Directive. Table 1 indicates basic parameters of this TSI and their correspondence to the essential requirements as explained in Appendix III of the Directive.

Table 1: Basic parameters and their correspondence to the essential requirements

clause	title	Essential requirements				
		Safety	R&A	Health	Environm. protection	Technical Compatibility
4.2.2.1.1	End coupling	1.1.1, 1.1.3, 1.1.5, 2.4.1				
4.2.2.1.2	Inner coupling	1.1.1, 1.1.3, 2.4.1				
4.2.2.2	Strength of unit	1.1.1, 1.1.3, 2.4.1				
4.2.3.1	Gauging	1.1.1				2.4.3
4.2.3.2	Compatibility with load carrying capacity of lines	1.1.1				2.4.3
4.2.3.3	Compatibility with train detection systems	1.1.1				2.4.3
4.2.3.4	Axle bearing condition monitoring	1.1.1	1.2			2.4.3
4.2.3.5.1	Safety against derailment running on twisted track	1.1.1,1.1.2, 2.4.1				2.4.3
4.2.3.5.2	Running dynamic behaviour	1.1.1 1.1.2				2.4.3
4.2.3.6.1	Structural design of bogie frame	1.1.1, 1.1.2, 1.1.3				
4.2.3.6.2	Characteristics of wheelset	1.1.1, 1.1.2, 1.1.3				2.4.3
4.2.3.6.3	Characteristics of wheel	1.1.1, 1.1.2, 1.1.3				2.4.3
4.2.3.6.4	Characteristics of axle	1.1.1, 1.1.2, 1.1.3				
4.2.3.6.5	Axle box / bearing	1.1.1, 1.1.2, 1.1.3				
4.2.3.6.6	Variable gauge wheelsets	1.1.1, 1.1.2 1.1.3				
4.2.4.2	Brake - Safety requirements	1.1.1, 1.1.3	1.2 2.4.2			

clause	title	Essential requirements				
		Safety	R&A	Health	Environmental protection	Technical Compatibility
4.2.4.3.1	Brake - General functional requirements	1.1.1 2.4.1	2.4.2			
4.2.4.3.2.1	Brake performance – In-service brake	1.1.1, 1.1.2 2.4.1	2.4.2			1.5
4.2.4.3.2.2	Brake performance – Parking brake	2.4.1				2.4.3
4.2.4.3.3	Brake - Thermal capacity	1.1.1, 1.1.3 2.4.1				2.4.3
4.2.4.3.4	Brake - Wheel slide protection (WSP)	2.4.1	2.4.2			
4.2.5	Environmental conditions	1.1.1 1.1.2				2.4.3
4.2.6.1	Fire safety - General	1.1.1 1.1.4				
4.2.6.1.2.1	Fire safety - Barriers	1.1.4				
4.2.6.1.2.2	Fire safety - Materials	1.1.4		1.3.2	1.4.2	
4.2.6.1.2.3	Fire safety - Cables	1.1.4 1.1.5		1.3.2	1.4.2	
4.2.6.1.2.4	Fire safety – Flammable liquids	1.1.4				
4.2.6.1.2.5	Fire safety – Running cabability	1.1.4	2.4.2			
4.2.6.2	Protection against electric hazard	1.1.5 2.4.1				
4.2.6.3	Attachment device for rear-end signal	1.1.1				

4 CHARACTERISATION OF THE SUBSYSTEM

4.1 INTRODUCTION

The rail system, to which the Directive applies and of which the wagons form a part, is an integrated system whose consistency shall be verified. This consistency shall be checked in particular with regard to the specifications of the rolling stock subsystem, its interfaces in relation to the other subsystems of the rail system in which it is integrated, as well as the operating and maintenance rules.

The common characteristics of the wagon are defined in the present chapter 4 of this TSI and include, as far as possible, those related to the compatibility with infrastructure. The relevant parameters are available in the technical file set out in Annex VI of Directive 2008/57/EC. This transparency enables the railway undertakings to deal with their responsibilities.

Except where this is strictly necessary for the interoperability of the rail system, the functional and technical specifications of the wagons and its interfaces described in section 4.2 and 4.3 of this TSI, do not impose the use of technical solutions.

Innovative solutions, which do not fulfil the requirements specified in this TSI and/or which are not assessable as stated in this TSI, require new specifications and / or new assessment methods. In order to allow technological innovation, these specifications and assessment methods shall be developed by the process “innovative solution” described in chapter 6 of this TSI.

4.2 FUNCTIONAL AND TECHNICAL SPECIFICATIONS OF THE SUBSYSTEM

4.2.1 General

In light of the essential requirements in chapter 3 of this TSI, the functional and technical specifications of the wagon part of the rolling stock subsystem are grouped and sorted out in the following clauses of this chapter:

- Structures and mechanical parts
- Vehicle track interaction and gauging
- Brake
- Environmental conditions
- System protection

When the functional and technical specifications, that are necessary in order to meet the essential requirements, have not been developed concerning a particular technical aspect, this aspect is identified as an open point in the relevant clause. As required in article 5(6) of the Directive all open points are listed in Appendix A of this TSI. As required in article 17(3) of the Directive open points shall be addressed by the application of national technical rules.

4.2.2 Structures and mechanical part

4.2.2.1. Mechanical Interface

4.2.2.1.1 End coupling

The end coupling is the mechanical interface between units forming a train.

The coupling system shall be designed in a way that no human presence between the units to be coupled / uncoupled shall be required whilst either one unit is moving.

End couplings shall be resilient and capable of withstanding the forces in accordance with the defined design operating state of the unit.

4.2.2.1.2 Inner coupling

The inner coupling is the mechanical interface between elements forming a unit.

The inner coupling shall be resilient and capable of withstanding the forces in accordance with the defined design operating state of the unit.

The longitudinal strength of the inner coupling(s) shall be equal to or higher than the one of the end coupling(s) of the unit, unless each element is equipped with independent power brakes.

The mechanical interface between two elements of an articulated unit shall be at least equally resistant in the longitudinal direction as the end coupling of the unit.

4.2.2.2. Strength of unit

The structure of a unit body, any equipment attachments and lifting and jacking points shall be designed such that no cracks, no significant permanent deformation or ruptures occur under the load cases defined in chapter 5 of EN12663-2:2010.

The jacking positions shall be marked on the unit. The marking shall comply with clause 4.5.13 of EN 15877-1:2010.

4.2.3 Track interaction and gauging

4.2.3.1. Gauging

The reference contour and its associated calculation rules limit the outer dimensions of the unit.

In order to establish the compatibility with infrastructure, the compliance with the reference contour associated to the unit (G1, GA, GB and GC), shall be determined by the kinematic method as described in EN 15273-2:2009.

4.2.3.2. Compatibility with load carrying capacity of lines

The vertical loading characteristics of the unit shall be determined in order to check compatibility with the load carrying capacity of lines.

The permissible payload a unit may carry, for axle loads up to and including 25t, shall be determined by application of clauses 6.1 and 6.2 of EN 15528:2008.

4.2.3.3 Compatibility with train detection systems

If the unit is intended to be compatible with one or more of the following train detection systems this shall be established by compliance with the corresponding clauses 4.2.3.3.1, 4.2.3.3.2 and 4.2.3.3.3 of this TSI.

4.2.3.3.1 Train detection systems based on track circuits

The compatibility with the train detection systems based on track circuits is provided if the unit is complying with the requirements specified in the CR CCS TSI Annex A, Appendix 1 on

- axle distances (clauses 2.1.1, 2.1.2 and 2.1.4),
- axle loads (clauses 3.1.1 and 3.1.2) and
- electrical resistance (clauses 3.5.1 and 3.5.2).

4.2.3.3.2 Train detection systems based on axle counters

The compatibility with the train detection systems based on axle counters is provided if the unit is complying with the requirements specified in the CR CCS TSI Annex A, Appendix 1 on

- axle distances (clauses 2.1.1 - 2.1.3),
- wheel geometry (clauses 2.2.1 - 2.2.4),
- metal free space around wheels (clause 3.2.1) and
- wheel material (clause 3.4.1).

4.2.3.3.3 Train detection systems based on loop equipment

The compatibility with the train detection systems based on loop equipment is provided if the unit is complying with the requirements specified in the CR CCS TSI Annex A, Appendix 1 on

- metal mass of the vehicle (clause 3.3).

4.2.3.4 Axle bearing condition monitoring

The axle bearing condition shall be monitored either by

- Line side detection equipment or
- Onboard equipment.

If the unit is intended to be monitored by line side equipment the unit shall be compliant with clauses 5.1 and 5.2 of EN 15437-1:2009 in order to ensure sufficient visibility. The use of onboard equipment is an **open point** in this TSI.

4.2.3.5 Running safety

The dynamic behaviour of a vehicle has a strong influence on safety against derailment, running safety and track loading.

4.2.3.5.1 Safety against derailment running on twisted track

The unit shall be designed to ensure safe running on twisted track, taking into account specifically the transition phase between canted and level track and cross level deviations.

The demonstration of compliance is described in clause 6.2.2.1 of this TSI.

4.2.3.5.2 Running dynamic behaviour

The unit shall be designed to provide safe movement up to the maximum design speed.

The running dynamic behaviour of a unit shall be proven either by

- following the procedures set out in chapter 5 of EN 14363:2005, or
- performing simulations using a validated model.

The demonstration of compliance is described in clause 6.2.2.2 of this TSI.

For units equipped with running gear assessed on interoperability constituent level in accordance with clause 6.1.2.1 of this TSI, a specific test or simulation on subsystem level is not required.

4.2.3.6 Running gear

The running gear shall guarantee to carry and guide the unit safely as well as to transmit braking forces where so required.

4.2.3.6.1 Structural design of bogie frame

The integrity of the structure of a bogie frame, all attached equipment and body to bogie connection shall be demonstrated based on methods as set out in clause 9.2 of EN 13749:2005.

The demonstration of compliance is described in clause 6.1.2.1 of this TSI.

4.2.3.6.2 Characteristics of wheelsets

The wheelset assembly shall be able to transmit forces and torque between the fitted elements.

The geometric dimensions of the wheelsets, as defined in Figure 1, shall be compliant with limit values specified in table 2. These limit values shall be taken as design values (new wheelset) and shall be stated as in-service limit values in the maintenance file described in section 4.5 of this TSI.

Table 2: In service limits of the geometric dimensions of wheelsets

Designation	**Wheel diameter D (mm)**	**Minimum value (mm)**	**Maximum value (mm)**
Requirements linked to subsystem			
Front-to-front dimension (S_R) (Distance between active faces) $S_R = A_R+S_d$(left wheel)+S_d(right wheel)	D > 840	1410	1426
	330 ≤ D ≤ 840	1415	
Back to back distance (A_R)	D > 840	1357	1363
	330 ≤ D ≤ 840	1359	

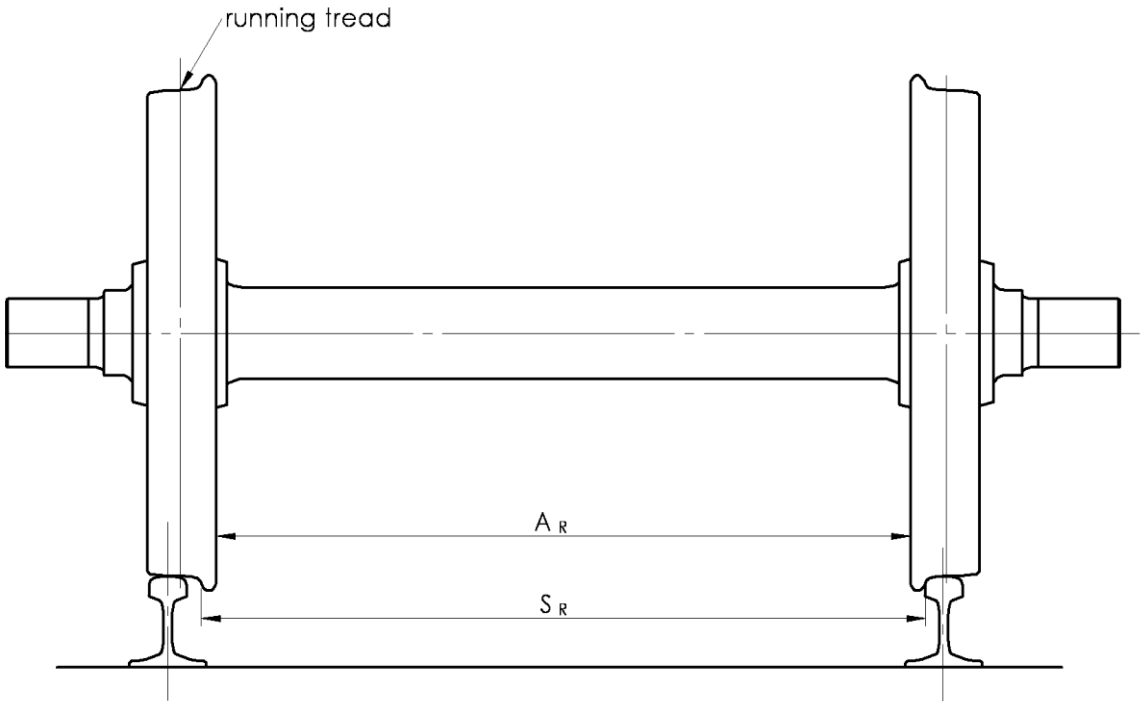

Figure 1: Symbols for wheelsets

The demonstration of compliance is described in clause 6.1.2.2 of this TSI.

4.2.3.6.3 Characteristics of wheels

The characteristics of the wheels shall ensure the transmission of forces and torque as well as the resistance against thermal load where so required.

Table 3: In service limits of the geometric dimensions of wheels

Designation	Wheel diameter D (mm)	Minimum value (mm)	Maximum value (mm)
Width of the rim B_R (With a maximum Burr of 5mm)	D ≥ 330	133	140
Thickness of the flange (S_d)	D > 840	22	33
	330 ≤ D ≤ 840	27,5	
Height of the flange (S_h)	D > 760	27,5	36
	330 ≤ D ≤ 760	31,5	
Face of flange (q_R)	≥ 330	6.5	

The geometrical dimensions of the wheels as defined in Figure 2 shall be compliant with limit values specified in table 3. These limit values shall be taken as design values and shall be stated as in-service limit values in the maintenance file described in section 4.5 of this TSI.

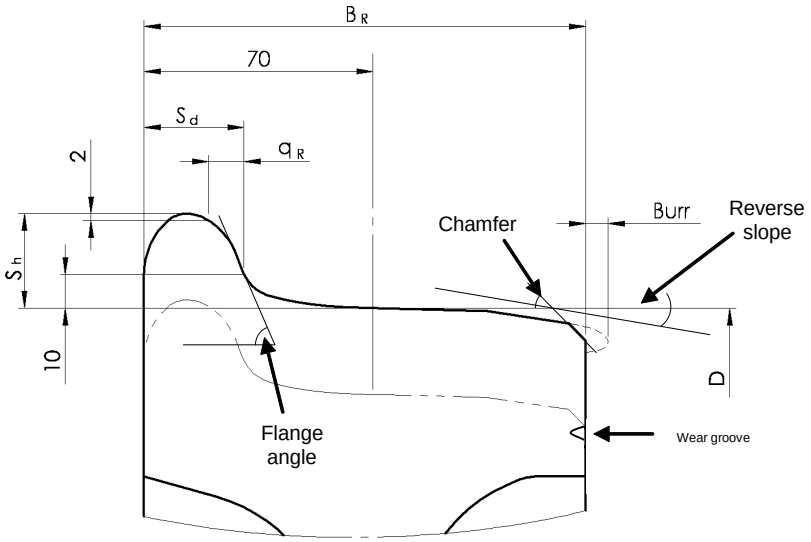

Figure 2: Symbols for wheels

The demonstration of compliance is described in clause 6.1.2.3 of this TSI.

Other types of wheels are permitted for vehicles restricted to national use. In that case the decision criteria and the fatigue stress criteria shall be specified in national rules. Those national rules shall be notified by Member States in accordance with Article 3.

4.2.3.6.4 Characteristics of axles

The characteristics of the axle shall ensure the transmission of forces and torque.

The demonstration of compliance is described in clause 6.1.2.4 of this TSI.

4.2.3.6.5 Axle boxes / bearings

The axle box and the rolling bearing shall be designed with consideration of mechanical resistance and fatigue characteristics. Temperature limits reached in service relevant for the hot box detection shall be defined.

The demonstration of compliance is described in clause 6.2.2.3 of this TSI.

4.2.3.6.6 Variable gauge wheelsets

This requirement is applicable to units equipped with variable gauge wheelsets with changeover between two track gauges.

The changeover mechanism of the wheelset shall ensure the safe locking in the correct intended axial position of the wheel and any brake equipment attached.

The conformity assessment of the requirements specified in this clause is an **open point**.

4.2.4 Brake

4.2.4.1 General

The purpose of the train brake system is to ensure that

- the train's speed can be reduced,
- the train's speed can be maintained on a slope
- the train can be stopped within the maximum allowable braking distance and that
- the train can be immobilised.

The primary factors that influence the braking performance and the braking process are

- the braking power,
- the train mass,
- the speed,
- the allowable braking distance,
- the available adhesion and
- the track gradient.

The brake performance of a train is derived from the individual brake performance of each unit in the train.

4.2.4.2 Safety requirements

The braking system contributes to the safety level of the railway system. Therefore the design of the braking system of a unit has to undergo a risk assessment considering the hazard of complete loss of the brake capability of the unit.

One or a combination of the following risk acceptance principles as set out in the CSM article 3(19), 3(20) and 3(21) shall be deployed for the risk assessment:

- the application of codes of practice,
- a comparison with a reference (or similar) system and/or
- an explicit risk estimation.

4.2.4.3 Functional and technical requirements

4.2.4.3.1 General functional requirements

The brake equipment of the unit shall provide the functions of braking such as the application and the release of the brake, upon a transmitted signal. The brake shall be:

- continuous, the brake application or release signal is transmitted from a central command to the whole train by a control line
- automatic, an inadvertent disruption of the control line shall lead to brake activation on all units of the train. Each parts of the train shall be brought to stand still
- disengageable, which enables its release and isolation.

4.2.4.3.2. Brake performance

4.2.4.3.2.1 In-service brake

The brake performance of a train or a unit is its ability to decelerate. It is the result of the braking power available to decelerate the train or unit within defined limits and all factors involved in the conversion and dissipation of energy including train resistance.

The brake performance of a unit shall be calculated in accordance with EN 14531-6:2009 or UIC 544-1:2010 . The calculation shall be validated by tests as set out in UIC 544-1:2010, except for cases as set out in UIC 544-1:2010.

4.2.4.3.2.2 Parking brake

A Parking Brake is a brake used to prevent parked rolling stock moving under the specified conditions taking into account the place, wind, gradient and rolling stock loading state, until intentionally released.

If the unit is equipped with a parking brake, the following requirements shall be met:

- the immobilisation shall remain until intentionally released.
- where it is not possible to identify the state of the parking brake directly, an indicator showing the state shall be provided on both sides on the outside of the vehicle.
- the minimum parking brake performance, considering no wind, shall be determined by calculations as defined in the standard clause 6 of EN 14531-6:2009.
- the minimum performance of the parking brake shall be marked on the unit. The marking shall comply with clause 4.5.25 of prEN 15877-1:2009. The parking brake of a unit shall be designed with a wheel/rail (steel/steel) adhesion factor not higher than 0,15.

4.2.4.3.3 Thermal capacity

The brake equipment shall be able to withstand one emergency brake application without any adverse thermal or mechanical damage.

The braking power, the unit is capable to withstand without any adverse thermal or mechanical damage, shall be defined and expressed in terms of speed and brake application time.

The demonstration of compliance is described in clause 6.2.2.4 of this TSI.

4.2.4.3.4 Wheel slide protection (WSP)

Wheel slide protection (WSP) is a system designed to use the maximum available adhesion by decreasing, holding or increasing the brake force to prevent wheel sets from locking and uncontrolled sliding. Thereby the stopping distance shall be optimized.

If an electronic WSP-control is used negative effects caused by malfunctions of WSP shall be reduced by suitable system design processes and technical configuration.

The WSP shall not alter the functional characteristics of the brakes. The vehicle's air equipment shall be dimensioned such that the air consumption of the WSP does not impair the performance of the pneumatic brake. The design process of the WSP shall take into account that the WSP has no detrimental effect on the constituent parts of the vehicle (brake gear, wheel tread, axle boxes, etc).

The following types of units shall be fitted with WSP:

- Equipped with all types of brake block, for which the maximum mean utilisation of adhesion is greater than 0,12.
- Equipped with disc brakes only and/or with composite brake blocks, for which the maximum mean utilisation of adhesion is greater than 0,11.

4.2.5 Environmental conditions

The unit shall be designed for operation under the range of climatic conditions occurring in Europe as expressed by the external temperature range of -40°C to +40°C. The provisions taken to meet the requirements, whether design or test related, shall be recorded in the technical file. In particular provisions concerning the verification of the following functions:

- Coupling function, only the resiliency of couplings.
- Brake function, including brake equipment such as the brake cylinder; air reservoirs; any interface connection with another unit (hoses etc).

The demonstration of compliance is described in clause 6.2.2.5 of this TSI.

4.2.6 System protection

4.2.6.1 Fire safety

4.2.6.1.1 General

The fire safety aspects of the unit design shall be aimed at

- preventing a fire from occurring,
- limiting the effects if a fire occurs.

The goods carried on the unit are not part of the unit and do not have to be taken into account in the conformity assessment.

4.2.6.1.2. Functional and technical specification

4.2.6.1.2.1Barriers

All significant potential fire sources and high risk components on the unit shall be identified by risk assessment and suitable and sufficient measures shall be taken to reduce the risk of a fire spreading. In order to limit the effects of fire, fire barriers with integrity of at least 15 minutes shall be installed between potential fire sources (high risk components) and the carried load.

The demonstration of compliance is described in clause 6.2.2.6.1 of this TSI.

4.2.6.1.2.2 Materials

All permanent materials used on the unit shall have limited ignitability and flame spread properties, tested in accordance with an appropriate standard, unless

- the material is separated from all potential fire risks on the unit by a fire barrier and the safe application is supported by a risk assessment or
- the component has a mass <400g, and is located within a horizontal distance of ≥40 mm and a vertical distance of ≥400mm to other non tested components.

The demonstration of compliance is described in clause 6.2.2.6.2 of this TSI.

4.2.6.1.2.3 Cables

All electrical cables shall have a fire performance which is suitable and sufficient in accordance with the appropriate standards.

4.2.6.1.2.4 Flammable liquids

Flammable liquid tanks for fuelling auxiliary equipment to the unit, shall be suitable.

4.2.6.1.2.5 Running capability

The risk of an uncontrolled application of the brakes as a result of a fire shall be mitigated. For this both the lay-out of components and the materials used in the brake system shall be suitable and sufficient.

4.2.6.2. Protection against electrical hazards

4.2.6.2.1 Protective measures against indirect contact (protective bonding)

The impedance between vehicle body and the running rail shall be low enough to prevent hazardous voltages between them.

Units shall be bonded in accordance with the provisions as described in clause 6.4 of EN 50153:2002.

4.2.6.2.2 Protective measures against direct contact

The electrical installations and equipment of a unit shall be designed so as to protect persons from electric shock.

The unit shall be designed so that direct contact is prevented following the provisions set out in clause 5 of EN 50153:2002,.

4.2.6.3 Attachment devices for rear-end signal

At the end of all units, which may constitute the end of a freight train, a device shall be provided to install a rear-end signal composed of either:

- 2 lamps or
- 2 reflective plates.

The dimensions and position of these devices shall be as described in clause 6.3.1 of prEN16116-2. The unit shall provide for a clearance allowing the installation of lamps and plates as set out in Appendix E of this TSI.

4.3 FUNCTIONAL AND TECHNICAL SPECIFICATION OF THE INTERFACES

4.3.1 Interface with infrastructure subsystem

Table 4: Interface with infrastructure subsystem

Reference Conventional Rail WAG TSI	Reference Conventional Rail Infrastructure TSI
4.2.3.1 Gauging	4.2.4.1 Minimum structure gauge 4.2.4.2 Distance between track centres 4.2.4.5 Minimum radius of vertical curve
4.2.3.2 Axle load parameter	4.2.7.1 Track resistance to vertical loads 4.2.7.3 Lateral track resistance 4.2.8.1 Resistance of bridges to traffic loads 4.2.8.2 Equivalent vertical loading for earthworks and earth pressure effects 4.2.8.4 Resistance of existing bridges and earthworks to traffic loads
4.2.3.5.2 Running dynamic behaviour	4.2.9 Track geometrical quality
4.2.3.6.2 Characteristics of wheelset 4.2.3.6.3 Characteristics of wheels	4.2.5.1 Nominal track gauge 4.2.5.6 Rail head profile for plain line 4.2.6.2 In service geometry of switches and crossings

4.3.2 Interface with operation subsystem

Table 5: Interface with operation subsystem

Reference Conventional Rail WAG TSI	Reference Conventional Rail Operation TSI
4.2.2.2 Lifting and jacking	4.2.3.6.3 Contingency arrangements
4.2.3.1 Gauging	4.2.2.5 Train composition
4.2.3.2 Axle load parameter	4.2.2.5 Train composition
4.2.4 Brake	4.2.2.6 Train braking
4.2.6.3 Attachment devices for rear-end signal. Appendix E Rear-end signal	4.2.2.1.3.2 Rear-end

4.3.3 Interface with the Control, command and signalling subsystem

Table 6: Interface with control, command and signalling subsystem

Reference Conventional Rail WAG TSI	Reference Conventional Rail CCS TSI
4.2.3.3.1 Rolling stock characteristics compatible with train detection system based on track circuits	Appendix A App 1 - Vehicle geometry, Vehicle design, Isolating emissions, EMC
4.2.3.3.2 Rolling stock characteristics compatible with train detection system based on axle counters	Appendix A App 1 - Vehicle geometry, Wheel geometry, Vehicle design, EMC
4.2.3.3.3 Rolling stock characteristics compatible with train detection system based on loop equipment	Appendix A App 1 - Vehicle metal mass

4.4 OPERATING RULES

Operating rules are developed under the railway undertaking safety management system. They shall be based on the documentation related to operation.

The documentation related to operation describes the wagon characteristics in relation to the design operating state to be considered in order to define the operating rules in normal and in various reasonably foreseeable degraded modes.

The documentation related to operation is composed of:

- a description of operation in normal mode, including the operational characteristics and limitations of the unit (e.g. vehicle gauge, maximum design speed, axle loads, brake performance, compatibility with train detection systems,...).
- a description of operation in degraded mode (when equipment or functions described in this TSI suffer safety failures) as far as can reasonably predicted , together with the related acceptable limits and operating conditions of the unit that could be experienced.

4.5 MAINTENANCE RULES

Maintenance is a set of activities intended to keep a functional unit in, or to restore it to a state in which it can perform its required function (definition as per standard EN 13 306).

The following documents being part of the technical file as set out in Annex VI of Directive 2008/57/EC are necessary to undertake maintenance activities on wagons:

- General documentation (clause 4.5.1)
- The maintenance design justification file (clause 4.5.2) and
- The maintenance description file (clause 4.5.3).

The applicant has to provide the initial version of the general documentation. This documentation might be modified later by the Entity in charge of maintenance under its responsibility as set out in Article 14a of the safety directive taking into account the existing operating and maintenance conditions of the unit.

4.5.1 General documentation

The general documentation comprises of:

- Drawings and description of components.
- Any legal requirement concerning the maintenance of a wagon.
- Drawing of systems (electrical, pneumatic, hydraulic and control-circuit diagrams).
- Additional onboard systems (description of the systems including description of functionality, specification of interfaces and data processing and protocols).
- Configuration files for each vehicle (parts list and bill of material).

4.5.2 Maintenance design justification file

The maintenance design justification file explains how maintenance activities are defined and designed in order to ensure that the rolling stock characteristics will be kept within permissible limits of use during its lifetime. The file shall give input data in order to determine the criteria for inspection and the periodicity of maintenance activities. The maintenance design justification file consists of

- precedents, principles and methods used to design the maintenance of the unit.
- limits of the normal use of the unit (e.g. km/month, climatic limits, foreseen types of loads etc.).
- relevant data used to design the maintenance and origin of these data (return of experience).
- tests, investigations and calculations carried out to design the maintenance.

4.5.3 Maintenance description file

The maintenance description file describes how maintenance activities can be conducted. Maintenance activities include, among others, inspections, monitoring, tests, measurements, replacements, adjustments and repairs.

Maintenance activities are split into

- preventive maintenance; scheduled and controlled
- corrective maintenance

The maintenance description file includes the following:

- Component hierarchy and functional description. The hierarchy sets up the boundaries of the rolling stock by listing all the items belonging to the product structure of that rolling stock and using an appropriate number of discrete levels. The lowest item of the hierarchy shall be a replaceable component;
- Parts list: the parts list shall contain the technical and functional descriptions of the spare parts (replaceable units) and the references from the spare part provider and manufacturer, in order to allow identification and procurement of the correct spare parts. The list shall include all parts specified for changing on condition, or which may require replacement following electrical or mechanical malfunction, or which will foreseeable require replacement after accidental damage.
  Interoperability constituent shall be indicated and referenced to their corresponding declaration of conformity.
- The limit values for components which are not to be exceeded in service are to be stated; the possibility of specifying operational restrictions in degraded mode (limit value reached) is permitted.
- European legal obligations: where components or systems are subject to specific European legal obligations these obligations shall be listed.
- A maintenance plan i.e. the structured set of tasks to perform the maintenance including the activities, procedures and means. The description of the maintenance activities include:
  - Disassembly/assembly instructions drawings necessary for correct assembly/disassembly of replaceable parts.
  - Maintenance criteria.
  - Checks and tests.
  - Tools and materials required to undertake the task.
  - Consumables required to undertake the task.
  - Personal protective safety provision and equipment.
- Necessary tests and procedures to be undertaken after each maintenance operation before re-entry into service of rolling stock;

4.6 PROFESSIONAL COMPETENCIES

The professional competencies of staff required for the operation and maintenance of wagons are not covered by this TSI.

4.7 HEALTH AND SAFETY CONDITIONS

The provisions for health and safety of staff required for the operation and maintenance of wagons are covered by the essential requirements No. 1.1.5, 1.3.2, 2.5.1, 2.6.1 (as numbered in the Directive); the table in chapter 3 mentions the technical clauses of this TSI in relation to these essential requirements.

In particular, the following clauses of section 4.2 of this TSI specify provisions for health and safety of staff:

- Clause 4.2.2.1.1: End coupling
- Clause 4.2.6.1: Fire safety
- Clause 4.2.6.2: Protection against electrical hazards.

5 INTEROPERABILITY CONSTITUENTS

5.1 GENERAL

Interoperability constituents (IC), as defined in article 2(f) of the Directive, are listed in section 5.3 of this TSI together with

- their area of use covering parameters of the subsystem and
- the reference to corresponding requirements defined in section 4.2 of this TSI.

When a requirement is identified in section 5.3 of this TSI as being assessed at IC level, an assessment for the same requirement at subsystem level is not required.

5.2 INNOVATIVE SOLUTIONS

As stated in section 4.1 of this TSI, innovative solutions may require new specifications and / or new assessment methods. Such specifications and assessment methods shall be developed by the process described in clause 6.1.3 of this TSI whenever an innovative solution is envisaged for an interoperability constituent.

5.3 INTEROPERABILITY CONSTITUENT SPECIFICATION

5.3.1 Running gear

The running gear shall be designed for an application range, the area of use, as defined by the following parameters:

- Maximum speed
- Maximum cant deficiency
- Minimum tare of the unit
- Maximum axle load
- Range of distances between bogie pivots or range of wheelbase of “two-axle wagons”
- Maximum height of centre of gravity of empty unit
- Coefficient of height of centre of gravity of loaded unit
- Minimum torsional stiffness coefficient of car body
- Maximum mass distribution coefficient for empty units with :

$$\frac{1}{2a^*} \cdot \sqrt{\frac{I_{zz}}{m}}$$

Izz moment of inertia of the car body relative to the vertical axis through the centre of gravity of the car body
m mass of the car body
2a* wheelbase

- Minimum nominal wheel diameter

- Rail inclination

The parameters speed and axle load may be considered in combination in order to define the appropriate area of use (e.g. maximum speed and tare weight).

The running gear shall comply with the requirements expressed in clause 4.2.3.5.2 and 4.2.3.6.1 of this TSI. These requirements shall be assessed at IC level.

5.3.2 Wheelset

The wheelset shall be assessed and designed for the area of use as defined by:

- nominal wheel tread diameter.
- maximum vertical static force.

A wheelset shall comply with the requirements on geometrical and mechanical parameters defined in clause 4.2.3.6.2 of this TSI. These requirements shall be assessed at IC level.

5.3.3 Wheel

A wheel shall be designed and assessed for an area of use defined by

- nominal tread diameter.
- maximum vertical static force, maximum speed and service life.
- maximum braking energy.

A wheel shall comply with the requirements on geometrical, mechanical and thermo mechanical parameters defined in clause 4.2.3.6.3 of this TSI. These requirements shall be assessed at IC level.

5.3.4 Axle

An axle shall be designed and assessed for an area of use defined by

- maximum vertical static force.

An axle shall comply with the requirements on mechanical parameters defined in clause 4.2.3.6.4 of this TSI. These requirements shall be assessed at IC level.

5.3.5 Rear-end signal

The rear-end signal, as described in Appendix E of this TSI, is an independent IC. There are no requirements in section 4.2 of this TSI dealing with the rear-end signal. Its assessment by the notified body is not part of the assessment of the subsystem.

6 CONFORMITY ASSESSMENT OF CONSTITUENTS AND VERIFICATION OF THE SUBSYSTEM

6.1 INTEROPERABILITY CONSTITUENT

6.1.1 Modules

The conformity assessment of an interoperability constituent shall be performed in accordance with the module(s) described in the following table.

Table 9: Modules for conformity assessment of interoperability constituents

Module CA1	Internal production control plus product verification by individual examination
Module CA2	Internal production control plus product verification at random intervals
Module CB	EC-Type examination
Module CD	Conformity to type based on quality management system of the production process
Module CF	Conformity to type based on product verification
Module CH	Conformity based on full quality management system
Module CH1	Conformity based on full quality management system plus design examination

These modules are specified in detail in the Commission Decision 2010/713/EU.

6.1.2 Conformity Assessment procedures

The manufacturer or his authorised representative established within the Community shall choose one of the modules or module combinations indicated in the following table in accordance with the required constituent.

Table 10: Modules to be applied for interoperability constituents

Clause	Constituent	Modules				
		CA1 or CA2	CB+CD	CB+CF	CH	CH1
4.2.3.6.1	Running gear		X	X		X
	Running gear - established	X			X	
4.2.3.6.2	Wheelset	X(*)	X	X	X(*)	X
4.2.3.6.3	Wheel	X(*)	X	X	X(*)	X
4.2.3.6.4	Axle	X(*)	X	X	X(*)	X
5.3.4	Rear-end signal	X			X	

(*) Modules CA1, CA2 or CH may be used only in the case of products placed on the market, and therefore developed, before the entry into force of this TSI, provided that the manufacturer demonstrates to the NoBo that design review and type examination were performed for previous applications under comparable conditions, and are in conformity with the requirements of this TSI; this demonstration shall be documented, and is considered as providing the same level of proof as module CB or design examination according to module CH1.

Within the application of the chosen module or module combination the interoperability constituent shall be assessed against the requirements mentioned in section 4.2 of this TSI. If necessary, additional requirements concerning the assessment of particular interoperability constituents are given in the following clauses.

6.1.2.1 Running gear

The demonstration of compliance for the running gear is set out in Appendix B.2 of this TSI.

Units equipped with an established running gear as listed below are exempt from running dynamic testing as long as they are operated within the established area of use:

- Single axle running gear
  - Double link suspension
  - Niesky 2
  - Suspension S 2000
- Two-axle bogie running gear
  - Y25 family
  - Two-axle steering axle bogie
- Three-axle bogies
  - Three-axle bogie family with link suspension

The assessment of the bogie frame strength shall be based on clause 9.2 of EN 13749:2005.

6.1.2.2 Wheelset

The demonstration of compliance for the mechanical behaviour of the wheelset assembly shall be based on clause 3.2.1 of EN13260:2009, which defines limit values for the axial assembly force and the associated verification test.

A verification procedure shall exist to ensure at the assembly phase that no defects may detrimentally affect safety due to any change in the mechanical characteristics of the fitted parts of the axle.

6.1.2.3 Wheel

The mechanical characteristics of forged and rolled wheels shall be proven following the procedure as specified in clause 7 of EN 13979-1:2003+A1:2009.

If the wheel is intended to be used with brake blocks acting on the wheel running surface, the wheel shall be thermo mechanically proven by taking into account the

maximum braking energy foreseen. A type test, as described in clause 6.2 of EN 13979-1:2003+A1:2009 shall be performed in order to check that the lateral displacement of the rim during braking and the residual stress are within the specified tolerance limits.

The decision criteria of residual stresses for forged and rolled wheels are set out in EN 13979-1:2003+A1:2009.

A verification procedure shall exist to ensure at the production phase that no defects may detrimentally affect safety due to any change in the mechanical characteristics of the wheels. The tensile strength of the material in the wheel, the hardness of the running surface, the fracture toughness (only for tread braked wheels), resistance to impact, the material characteristics and the material cleanliness shall be verified. The verification procedure shall specify the batch sampling used for each characteristic to be verified.

6.1.2.4 Axle

In addition to the requirement on the assembly above, the demonstration of compliance for mechanical resistance and fatigue characteristics of the axle shall be based on clauses 4, 5 and 6 of EN13103:2009.

The decision criteria for the permissible stress are specified in clause 7 of EN 13103:2009.
A verification procedure shall exist to ensure at the production phase that no defects may detrimentally affect safety due to any change in the mechanical characteristics of the axles. The tensile strength of the material in the axle, the resistance to impact, the surface integrity, the material characteristics and the material cleanliness shall be verified. The verification procedure shall specify the batch sampling used for each characteristic to be verified.

6.1.3 Innovative solutions for Interoperability Constituents

If an innovative solution (as defined in clause 4.1 of this TSI) is proposed for an interoperability constituent as defined in section 5.2 of this TSI, the manufacturer or his authorised representative established within the Community shall state the deviations from the relevant clause of this TSI and submit them to the European Commission for analysis. In case the analysis results in a favourable opinion, the appropriate functional and interface specifications as well as the assessment method which are necessary to be included in the TSI in order to allow the use of this constituent will be developed.

The appropriate functional and interface specifications and the assessment methods so produced shall be incorporated in the TSI by the revision process.

By the notification of a decision of the Commission, taken in accordance with Article 29 of the Directive, the innovative solution may be permitted to be used before being incorporated into the TSI by the revision process.

6.2 SUBSYSTEM

6.2.1 Modules

The EC verification of the subsystem “wagon” shall be performed in accordance with the module(s) described in the following table.

Table 11: Modules for EC verification of subsystems

SB	EC-Type Examination
SD	EC verification based on quality management system of the production process
SF	EC verification based on product verification
SH1	EC verification based on full quality management system plus design examination

These modules are specified in detail in the decision _____.

6.2.2 EC verification procedures

The applicant shall choose one of the following combinations of modules or module for the EC verification of the subsystem.

- (SB+SD) or
- (SB+SF) or
- (SH1).

Within the application of the chosen module or module combination the subsystem shall be assessed against the requirements mentioned in section 4.2. If necessary, additional requirements concerning the assessment of particular constituents are given in the following clauses.

~~6.2.2.1 Strength of unit~~

~~The demonstration of conformity shall be based on chapters 6, 7 and 8 of EN 12663-2:2010.~~

6.2.2.1 Safety against derailment running on twisted track

The demonstration of conformity shall be carried out either in accordance with

- the procedure defined in section 4.1 of EN 14363:2005 or
- the method given in section 4.2 of prEN15839 by using the pre-calculation for standardised solutions.

6.2.2.2 Running dynamic behaviour

The demonstration of compliance shall be carried out in accordance with chapter 5 of EN 14363:2005.

As an alternative to performing on-track tests on two different rail inclinations, as set out in paragraph 5.4.4.4 in EN 14363:2005 it is permitted to perform tests on only one rail inclination if demonstrated that the tests cover the range of contact conditions defined in Appendix B1.1.

When an on-track test with normal measuring method is required to be performed the unit shall be assessed by the parameters set out in Appendix B.1.2 and B.1.3 of this TSI.

Alternatively, under the conditions stated in section 9.3 of prEN 15827:2009, a simulation may replace the above mentioned on-track tests.

The combination of the highest equivalent conicity and speed for which the unit meets the stability criterion in clause 5 of EN 14363:2005 shall be recorded in the report.

The required test conditions for on-track tests, as set out in EN 14363:2005, are not always fully achievable concerning

- track geometric quality and
- combinations of speed, curvature, cant deficiency.

In cases this is not fully achievable the demonstration of compliance is an **open point.**

6.2.2.3 Axle box / bearings

The demonstration of compliance for mechanical resistance and fatigue characteristics of the axle box and the rolling bearing shall be based on clause 6 of EN12082:2007 as well as the measurement of the required temperature limits.

6.2.2.4 Thermal capacity

Calculations, simulations or tests shall approve, that the temperature of the brake block, brake pad or brake disc does not exceed their thermal capacity. The following shall be taken into account:

- Concerning the emergency brake application: The critical combination of

- speed and
- payload

considering straight and level track, minimum wind and dry rails.

- Concerning the continuous brake application:
  - The range up to the maximum braking power,
  - the range up to the maximum speed and
  - the corresponding brake application time.

Brake blocks, listed in the Technical Document 02 (ERA/TD/2009-02/INT) are exempted from these calculations, simulations and tests under the defined conditions of nominal wheel diameter, maximum axle load and brake configuration.

6.2.2.5 Environmental conditions

Steel materials are deemed to comply with the range indicated in clause 4.2.5 of this TSI if specified for -20°C.

6.2.2.6 Fire safety

6.2.2.6.1 Barriers

Barriers shall be tested in accordance with EN1363-1 or with an equivalent method.

Steel sheets of at least 2mm thickness and aluminium sheets of at least 5mm thickness are deemed to comply with the integrity requirements without testing.

6.2.2.6.2 Materials

For the following materials and components the fire safety requirements are fulfilled without additional tests:

- Metals and alloys with inorganic coatings (such as, but not limited to: galvanized coating, anodic coating, chromate film, phosphate conversion coating).
- Metals and alloys with an organic coating with a nominal thickness less than 0.3 mm (such as, but not limited to paints, plastic coating, asphaltic coating).
- Metals and alloys with a combined inorganic and organic coating of which the nominal thickness of the organic layer is less than 0.3 mm.
- Glass, stoneware, ceramic and natural stone products,
- Materials that meet the requirements of category C-s3,d2 or higher in accordance with EN 13501-1:2007+A1:2009.

6.2.4 Innovative solutions

If the subsystem “wagon” includes an innovative solution (as defined in clause 4.1 of this TSI), the applicant shall state the deviations from the relevant clauses of the TSI, and submit them to the Commission for analysis. In case the analysis results in a favourable opinion, the appropriate functional and interface specifications as well as the assessment methods which are necessary to be included in the TSI in order to allow this solution will be developed.

The appropriate functional and interface specifications and the assessment methods so produced shall then be incorporated in the TSI by the revision process.

By the notification of a decision of the Commission, taken in accordance with Article 29 of the Directive, the innovative solution may be permitted to be used before being incorporated into the TSI by the revision process.

6.3 SUBSYSTEM CONTAINING INTEROPERABILITY CONSTITUENTS NOT HOLDING AN EC DECLARATION

A Notified Body is permitted to issue an EC certificate of verification of a subsystem, even if one or more of the interoperability constituents incorporated within the subsystem are not covered by a relevant EC declaration of conformity in accordance with this TSI (non-certified ICs), either in the case:

1. The constituent falls under the transition period as set out in Commission decision related to this TSI or
2. the constituent was manufactured before the entry into force of this TSI and the type of constituent has been
    - used in a subsystem already approved and
    - put in service in at least one Member State before the entry in force of this TSI.

The EC verification of the subsystem shall be carried out by the Notified Body against the requirements of chapter 4 using the corresponding requirements concerning assessment in chapter 6 of this TSI together with chapter 7 of this TSI except specific cases. For this verification the modules of the subsystem, set out in clause 6.2.2 of this TSI, apply.

Neither an EC declaration of conformity nor an EC certificate of conformity shall be drawn up for the interoperability constituents assessed in this manner.

The EC certificate of verification of the subsystem shall indicate clearly which interoperability constituents have been assessed by the Notified Body as part of the subsystem verification.

6.4 PROJECT PHASES WHERE ASSESSMENT IS REQUIRED

The assessment shall cover the following two phases as identified by “X” in the table F.1 of Appendix F in this TSI. In particular, where a type test is identified the conditions and requirements of section 4.2 of this TSI shall be considered.

- Design and development phase:
  - Design review and/or design examination
  - Type test: test to verify the design, if and as defined in the section 4.2 of this TSI.
- Production phase:
  - Routine test to verify the conformity of production. The entity in charge of the assessment of the routine tests is determined according to the assessment module chosen.

The Appendix F of this TSI is structured according to section 4.2 of this TSI. Where relevant, a reference to the sub clauses of section 6.1 and 6.2 of this TSI is given.

6.5 INTEROPERABILITY CONSTITUENTS IN ACCORDANCE WITH DECISION 2006/861/EC

Where a constituent has been identified as an IC in the Decision 2006/861/EC, assessed in accordance with the modules specified on Appendix Q to Decision 2006/861/EC and holding an EC declaration of conformity, its treatment under this TSI is set out as follows:

- In the case this constituent is not recognised as an IC in this TSI, neither the certificate nor the declaration are valid for the EC verification procedure related to this TSI.
- The following ICs shall not require a new conformity assessment under this TSI until the expiry of the corresponding certificate or declaration:
  - Wheelset.
  - Wheel.
  - Axle.

7 IMPLEMENTATION

7.1 AUTHORISATION FOR PLACING INTO SERVICE

Chapters 2 to 6 of this TSI and any specific provisions in section 7.3 apply in full to the rolling stock coming within the scope set out in section 1.2 which will be placed into service after this TSI enters into force.

7.1.1 Transitional period

During a transitional period, as defined in accordance with the Directive 2008/57/EC, Article 5(3-f), the application of this TSI is not mandatory, under the following conditions:

- Projects at advanced stage of development, as described in the clause 7.1.1.1.
- Contracts in course of performance, as described in the clause 7.1.1.2.
- Rolling stock of an existing design, as described in clause 7.1.1.3.

Any rolling stock placed in service after the end date of the transitional period described in this clause shall fully comply with this TSI without prejudice to Article 9 of the Directive 2008/57/EC which allows Member States to request derogations under the conditions set out in this Article.

7.1.1.1 Projects at advanced stage of development

This clause concerns rolling stock which is developed and produced under a project at an advanced stage of development.

It shall be shown that the conditions set out in article 2(t) of the Directive 2008/57/EC are met.

7.1.1.2 Contracts in course of performance

This clause concerns rolling stock which is developed and produced under a contract which is signed before the entry into force of this TSI.

The applicant has to bring evidence of the date of signature of the original contract applicable. The date of any addenda in the form of changes to an original contract shall not be taken into account when defining the date of signature of the contract in question.

7.1.1.3 Rolling Stock of an existing design

This clause concerns rolling stock which is produced in accordance with a design developed before the entry into force of this TSI.

The applicant has to prove that the newly built rolling stock will be produced in accordance with a documented design that has already been used to produce a rolling stock which has been authorised to be placed into service in a Member State before the date of entry into force of this TSI.

Any modification to an existing design, which has an impact on the overall safety level of the subsystem concerned, shall be assessed in accordance with the relevant parts of this TSI by applying the procedure as set out in Article 20 of the Directive 2008/57/EC. The Member State shall thus examine the extent of the design change and decide to what extent this TSI needs to be applied.

7.1.2 Mutual recognition of the first authorisation of placing in service

In accordance with article 23(1) of the Directive 2008/57/EC this TSI lays out the conditions under which a unit shall not be subject to any additional authorisation for placing in service. In the following these conditions are given:

- ...
- ...
- ...
- ...
- ...

7.2 SUBSTITUTION, RENEWAL AND UPGRADING

This TSI applies to

- substitutions of constituents,
- substitution of elements within a unit
- and to renewal or upgrading of wagons

in accordance with the conditions laid down in Article 20 of the Directive.

Concerning the substitution of constituents the following categories have to be considered.

- Certified ICs: Constituents which are defined as IC in chapter 5 of this TSI and which are holding a certificate of conformity or suitability for use.
- Non ICs: Any constituent, which is not defined as IC in chapter 5 of this TSI.

- Non-certified ICs. Constituents which are defined as IC in chapter 5 of this TSI and which are not holding a certificate of conformity or suitability for use.

The table 12 shows the possible permutations.

Table 12: Substitution permutation table

	...substituted by...		
	...certified ICs	**...non ICs**	**...non-certified ICs**
Certified ICs...	check	not possible	check
Non ICs...	not possible	Check	not possible
Non-certified ICs...	check	not possible	check

The ECM may under its responsibility substitute a constituent by another one utilising the same function and performance in accordance with the relevant TSI requirements considering these constituents are

- suitable, i.e. conform to the relevant TSI(s),
- used within its area of use,
- enabling interoperability,
- meeting the essential requirements and
- in line with restrictions eventually stated in the technical file

When the extent of the work leads to a different function or performance or in case of a substitution of an element within the unit, the contracting entity or the manufacturer is required to send the Member State concerned a file describing the project. The Member State decides whether the a new authorisation for placing in service is needed.

7.3 SPECIFIC CASES

7.3.1 Introduction

The specific cases, as listed in the following clause, are classified as:

- “P” cases: “permanent” cases.
- “T” cases: “temporary” cases, where it is recommended that the target system is reached by 2020 (an objective set in Decision No 1692/96/EC of the European Parliament and Council of 23 July 1996 on Community guidelines for the development of the trans-European transport network, as amended by Decision 884/2004/EC).

7.3.2 List of specific cases

List to be completed.

APPENDIX A OPEN POINTS

Certain technical aspects, corresponding to the essential requirements, which are not explicitly covered by the specifications, are open points. These are stipulated in section 4.2 of this TSI and listed in the table A.1.

Table A.1: List of open points

Element of the Rolling Stock sub-system	Clause	Technical aspect not covered by this TSI	Link to other subsystems to cover the open point
Axle bearing condition monitoring	4.2.3.4	Option on board equipment	Equipment not mandatory.
Test conditions for on-track tests as set out in the EN 14363 are not always fully achievable	4.2.3.5.2	track geometric quality and combinations of speed, curvature, cant deficiency (clause 5.4.2 of EN 14363).	
The changeover mechanism of the wheelset shall ensure the	4.2.3.6.6	Assessment of safe locking in the correct intended axial position of the wheel. Assessment of the locking in the correct position of this equipment shall be ensured.	

APPENDIX B SPECIFIC PROCEDURES FOR RUNNING DYNAMICS

B.1 Specific assessment concerning running dynamic testing following EN 14363

B.1.1Conditions for testing on one rail inclination

- The parameter equivalent conicity tan γe for tangent track and large radius curves shall be distributed so that tan γe = 0,2 ± 0,05 occurs in a range of the amplitude (y) of the wheelsets lateral displacement between +/-2 and +/-4 mm for a minimum of 50% of track sections.
- The instability criterion in EN14363:2005 shall be assessed for low-frequency body motions on at least two track sections with equivalent conicities less than 0.05 (mean value over the track sections).
- The instability criterion in EN14363:2005 shall be assessed on at least two track sections with equivalent conicities in accordance with the table B.1.

Table B.1: Conditions for contact conditions in relation to on-track testing

Maximum vehicle speed	Equivalent conicity
60 km/h < V ≤ 140 km/h	≥0,50
140 km/h < V ≤ 200 km/h	≥0,40
200 km/h < V ≤ 230 km/h	≥0,35
230 km/h < V ≤ 250 km/h	≥0,30

B.1.2Limit values for running safety

The limit values for running safety specified in clause 5.3.2.2 of EN 14363:2005 and for axle loads above 22.5 t in clause 5.3.2.2 of EN 15687:2010 shall be met and verified.

When the quotient of guiding force and wheel force (Y/Q) limit is exceeded, it is allowed to recalculate the Y/Q estimated maximum value in accordance with the following process:

- create an alternative test zone made up of all track sections with 300 m ≤ R ≤ 500 m,
- for the statistical processing per section, use xi (97,5%) instead of xi (99,85%),
- for statistical processing per zone, replace k = 3 (when using one-dimensional method) or Student coefficient t (N - 2; 99%) (when using two-dimensional method) by Student coefficient t (N-2; 95%).

Both results (before and after recalculation) shall be reported.

B.1.3Track loading limit values

The limit values for track loading specified in EN 14363:2005 clause 5.3.2.3 and for loads above 22.5 t in EN 15687:2010 clause 5.3.2.2 shall be met and verified when so required by the methodology of EN 14363:2005.

The quasi-static guiding force Yqst limit value shall be evaluated for curve radii $250 \leq R < 400$m.

The limit value shall be : $(Yqst)lim = (30 + 10500/Rm)$ kN, where

Rm = mean radius of the track sections retained for the evaluation.

When this limit value is exceeded due to high friction conditions, it is permitted to recalculate the estimated value of Yqst on the zone after replacing the individual (Yqst)i values on the track sections "i" where (Y/Q)ir (mean value of Y/Q ratio on the inner rail over the section) exceeds 0,40 by: (Yqst)i - 50[(Y/Q)ir - 0,4]. Both results (before and after recalculation) shall be reported.

The values of the Yqst, Qqst and mean curve radius (before and after recalculation) shall be recorded in the test report.

In case the Yqst value exceeds the limit value expressed above, the operational performance of the unit (e.g. maximum speed) may be limited by the infrastructure, considering track characteristics (e.g. curve radius, cant, rail height).

B.2 Qualification of running gear

Following successful testing the acceptable parameter variation range is given by the range between the nominal tested parameters extended as illustrated in figure B.1.

It is permitted to perform only one test and by doing so only validating the running gear for a limited range.

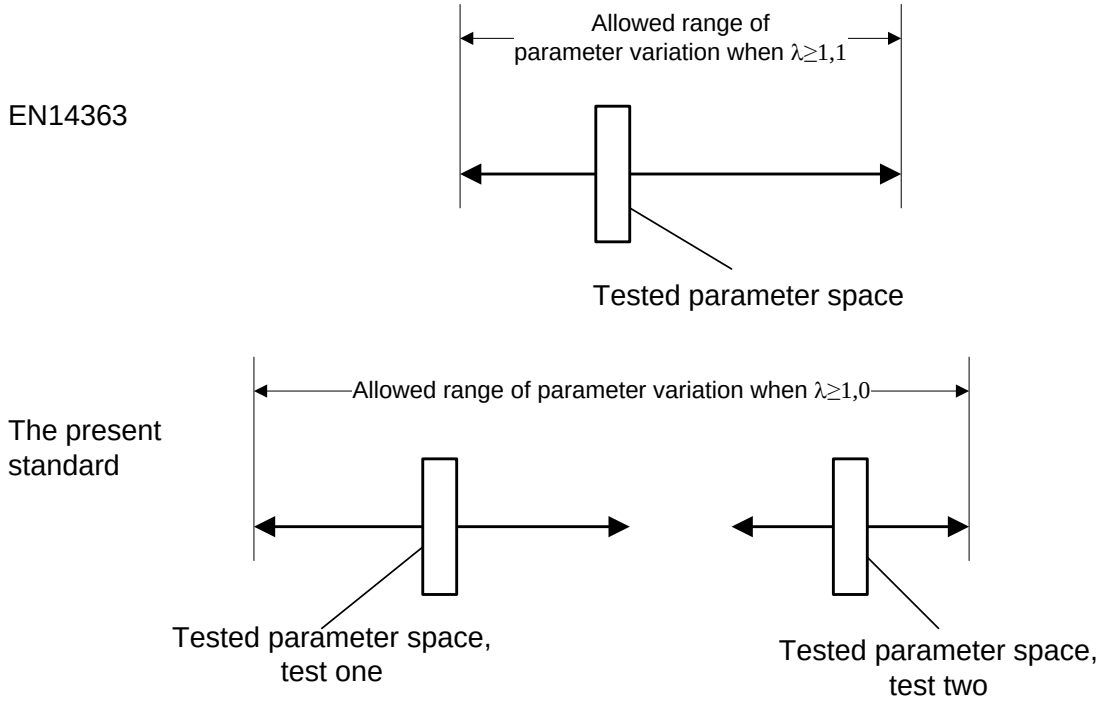

Figure B.1: Parameter variation ranges for the acceptance after successful testing compared to the process in EN 14363:2005

B.2.1 Test extent

The tests shall be carried out in accordance with the complete procedure in chapter 5 of EN 14363, considering the specific procedures as set out in Appendix B.1 of this TSI. The tests shall be performed for the same intended operating conditions (v_{adm} and l_{adm}):

- One test with a wagon of short running gear distance.
- One test with a wagon of long running gear distance

Other values of body parameters shall be within the ranges defined in table B.2.

Table B.2: Body parameters

		2-axle wagons		Bogie wagons	
		Short test wagon	**Long test wagon**	**Short test wagon**	**Long test wagon**
Running gear distance	*2a** [m] a)	≤ 7	≥ 9	≤ 7	≥ 13
Torsional stiffness	c_t^* [kNmm²/rad]	$0{,}5 \times 10^{10}$ ... 8×10^{10}			
a) 2a* is the distance between wheelsets for 2-axle wagons or the distance between bogies for bogie wagons and ct* is the vehicle body torsional stiffness coefficient.					

Note 1: For the purposes of assessment of running behaviour a typical loading condition must be tested. It is not necessary to test the worst possible density of the load using the maximum axle load and filling the whole loading gauge.

In addition, 2 axle wagons for speeds ≥100 km/h shall be tested in loaded condition also in sections of test zone 2 with clearances given by a gauge of ≥1450 mm in combination with wheelsets having distances between active faces at the minimum operation limit.

Note 2: It is desirable to perform such tests based on measurements of lateral acceleration, if it can be shown that a relationship exists between accelerations and the sum of the guiding forces and a related limit value was established.

Note 3: This requirement is intended to be shifted to the test conditions in EN 14363.

B.2.2 Range of running gear parameters for dispensation from on-track tests

Following successful testing in accordance with Appendix B.2.1 the acceptable parameter variation range for dispensation from on-track tests is given by the range between the nominal tested parameters extended as illustrated in figure B.1 and specified in tables B.3 and B.4.

All parameters given in these tables are nominal values. The upper limit of the acceptable range depends on the maximum tested value of the respective parameter, the lower limit on the minimum tested value.

In case of extension of the already applicable parameter range of a running gear, new tests shall be performed with parameters outside the previously tested range.

Table B.3: Accepted parameters for a single axle running gear which was tested successful in accordance with Appendix B.2.1 of this TSI

Nominal parameter		Minimum	Maximum
Maximum axle load	P	-	P_{tested}
Vertical eigenfrequency	v_z	0.9 v_z in load range	1.12 v_z in load range
Vertical damping		Tested characteristics	Tested characteristics
Lateral suspension characteristics		Tested characteristics	Tested characteristics
Wheel diameter	D	Diameter of tested application D_{nom} –90 mm	Diameter of tested application D_{nom} +90 mm

Table B.4: Accepted parameters for a bogie which was tested successful in accordance with Appendix B.2.1 of this TSI

Nominal parameter		Minimum	Maximum
Maximum axle load	P_{max}	-	$1,05 \cdot P_{max,tested}$
Bogie axle distance (between outer axles of the bogie)	$2a^+$	$2a^+_{tested}$	$2a^+_{tested}$ + 0,2 m
Vertical eigenfrequency (see Appendix C)	ν_z	$0,90 \cdot \nu_{z,tested}$ in load range	$1,12 \cdot \nu_{z,tested}$ in load range
Vertical Damping		Tested characteristics	Tested characteristics
Axle guiding longitudinal		Tested characteristics	Tested characteristics
Axle guiding lateral		Tested characteristics	Tested characteristics
Lateral secondary susp. characteristics		Tested characteristics	Tested characteristics
Yaw resistance of bogie[a)]	M^*_z	$0,80 \cdot M^*_{z,tested}$	$1,20 \cdot M^*_{z,tested}$
Moment of inertia of whole bogie (around z-axis)	I^*_{zz}	0	$1,10 \quad I^*_{zz,tested}$
Wheel diameter	D	D_{tested} –90 mm	D_{tested} +90 mm
Nominal height of centre pivot	h_{cp}	$h_{cP,tested}$ – 150 mm	$h_{cP,tested}$ + 50 mm

a) for a friction based yaw resistance torque measured at two specified loads typical for empty and loaded condition. For other systems, appropriate parameters must be used to control stability and safety against derailment in empty condition and maximum guiding force in loaded conditions.

B.2.3 Range of vehicle body parameters for dispensation from on-track tests

Following successful testing according to Appendix B.2.1of this TSI the acceptable parameter variation range for a dispensation from on-track tests is given by the range between the nominal tested parameters and extended where applicable as specified in table B.5. All parameters given in this table are nominal values. The upper limit of the acceptable range depends on the maximum tested value of the respective parameter, the lower limit on the minimum tested value.

To extend the applicable vehicle parameter range of a standardised running gear, test results of a third tested vehicle outside the previously tested range shall be used.

Table B.5: Accepted parameters for vehicles (included articulated wagons and permanently coupled units) equipped with a running gear which was tested successfully according to Appendix B.2.1 of this TSI

Nominal parameter		Minimum	Maximum
Distance between wheelsets (non bogie vehicles)	$2a^*$	Lowest value of 6 m and $2a^*_{tested}$	Highest value of 10 m and $2a^*_{tested}$
Distance between bogies (bogie vehicles)	$2a^*$	Lowest value of 6,5 m and $2a^*_{tested}$	$2a^*_{tested}$ + 3m
Centre of gravity height of empty wagon	h_{cg}	0	$1,2 \cdot h_{cg,empty,tested,\,max}$
Coefficient of height of centre of gravity - loaded vehicle [a)]	χ	0	$\chi_{loaded,tested,max}$ x $0,8(\lambda'-1)$ with λ' – factor for track loading parameters (see 3.10)
Torsional stiffness per car body	c_t^*	> $0,5\ 10^{10}$ kNmm²/rad	'-
Mean axle load of the tare unit (non-bogie wagon)	$P_{mean,tare}$	Smallest value of 5,75 t and $P_{mean,tare,tested}$	-
Mean axle load of the tare unit (bogie wagon)	$P_{mean,tare}$	Smallest value of 4 t and $P_{mean,tare,tested}$	-
Maximum axle load	P	-	$1,05 \cdot P_{tested}$
Mass distrib. coefficient (empty and loaded vehicle)	Φ	0	$1,2 \cdot \Phi_{tested}$

a) for evaluation of χadmissible cant deficiency Iadm of 130 mm for axle loads ≤ 225 kN and 100 mm for axle loads> 225 kN and up to 250 kN.

APPENDIX C ADDITIONAL OPTIONAL CONDITIONS FOR UNITS USED UNDER CERTAIN OPERATIVE REGIMES

In addition to the assessment against the core TSI requirements an applicant may ask the Notified Body for the assessment of conformity with the requirements set out in this Appendix. A unit which fulfils all the following conditions may be marked ???. A unit in accordance with all conditions of this Appendix except for those set out in C.3, C.6 and C.7 may be marked ???.

C.1 End coupling

The manual coupling system shall comply with the following requirements:

- the screw coupling system excluding the draw hook shall comply with the requirements of EN15566:2009 except clause 4.4 related to freight wagons,
- the draw hook shall comply to EN15566:2009 except clause 4.4 related to freight wagons and except the dimension “a” in Annex A Figure A.1.,
- the buffer shall comply with the requirements of the part EN15551:2009 related to freight wagons.
- There shall be no fixed parts within 40 mm of a vertical plane placed at the end of the fully compressed buffers.
- The space for shunting staff operation shall be in accordance to prEN 16116-2, clause 6.2.
- Where a combined automatic and screw coupler is fitted, it is permissible for the auto coupler head to infringe the Berne rectangle on the left hand side when it is stowed and the screw coupler is in use. In this case marking EN 15 877-1 Figure 78 is mandatory.
- the buffing centre line shall be located at a height between 940 and 1065 mm above rail level in all loading and wear conditions.
- the hook shall be located at a height between 920 and 1045 mm above rail level in all loading and wear conditions.
- The clearance for draw hook shall be in accordance with prEN16116-2:20__, clause 6.3.2.

Interaction of buffers and draw gear

- The characteristics of the buffers and draw gear shall be designed in order to enable the safe transit of curves in the track with a radius of 150 m. Two units with bogies coupled on straight track with touching buffers shall generate compressive forces not higher than 250 kN on a 150 m radius curve. There is no requirement specified for two axle wagons.

- The distance between the front edge of a draw-hook opening and the front side of the fully extended buffers shall be 355 mm + 45/-20 mm in the new condition as shown in Figure C.1:

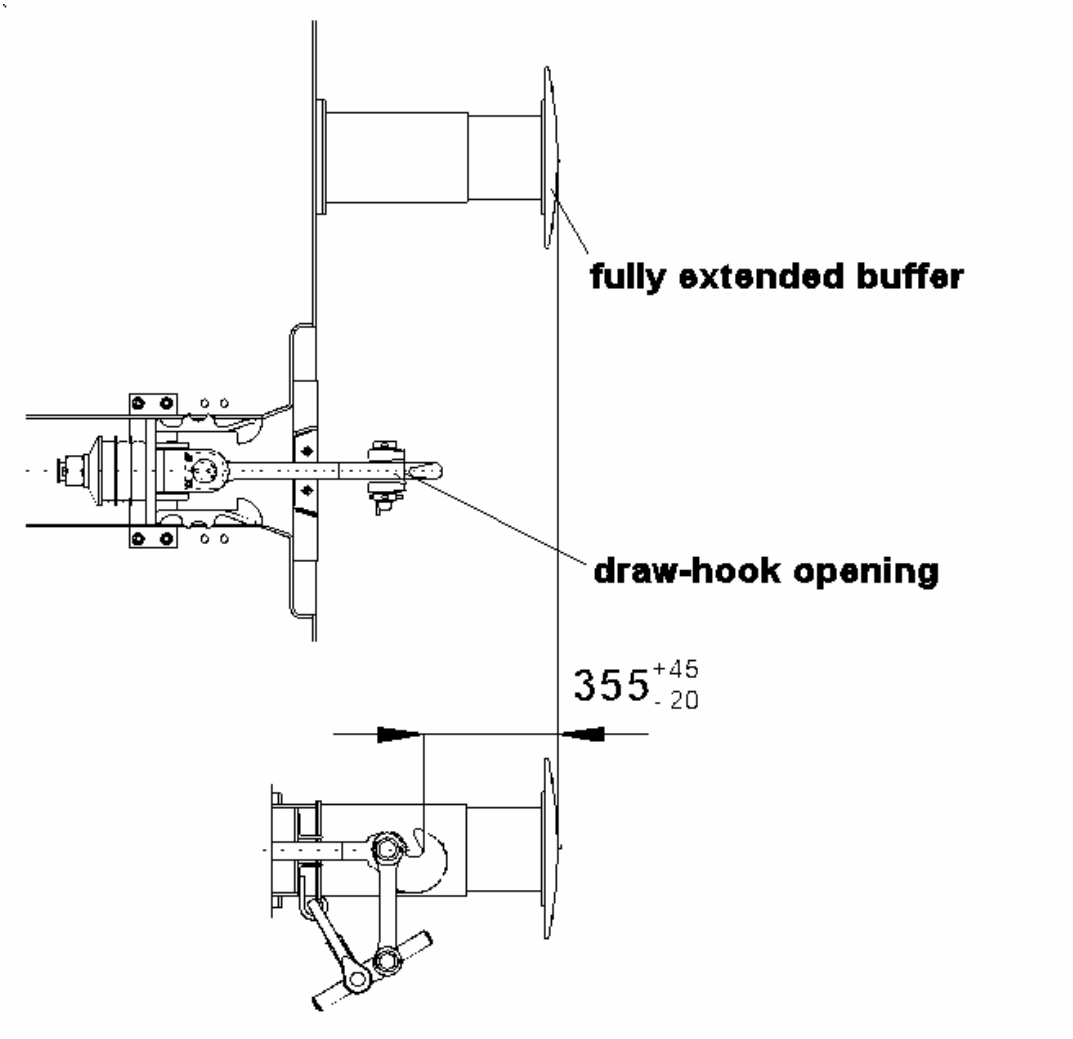

Figure C.1: Configuration of buffers and draw gear

Units designed for 1435mm and 1520mm or 1435mm and 1524mm, or 1435mm and 1668mm gauge network(s), equipped with manual coupling and “UIC” pneumatic brake system, shall be compatible with both,

- the interface requirements for “End Coupling” mentioned before, and
- former buffers layout of broad gauge networks.

In order to provide this full compatibility, it is permitted to have a different value of the distance between buffer centrelines, 1790 mm (Finland) and 1850 mm (Spain) taking into account clause 6.2.3.1 of EN 15551.

C.2 Footsteps and handrails

Concerning Footsteps and handrails sections 4.2, 4.3, 5 and 6.2.2 of prEN 16116-2:20__, shall apply.

C.3 Strength of main vehicle structure and equipment

In addition to the requirements of 4.2.2.2 of this TSI the unit shall be classified in Category F I in accordance with clause 5.1 of EN 12663-2:2010 with the following exception: units designed to carry motor vehicles or combined transport units without long stroke shock absorbers the Category F-II may be used.The requirements concerning the buffing tests in clause 8.2.5.1 of EN 12663-2:2010 applies.

C.4 Lifting and jacking

The unit shall comply with the following diagram on the free space under the re-railing places for re-railing:

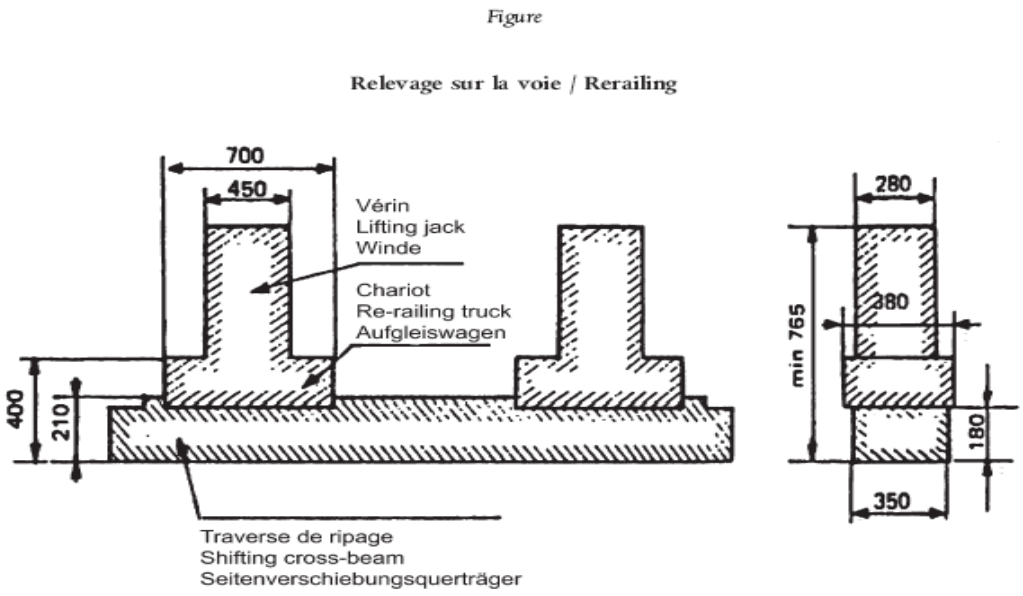

Figure C.2: Free spaces under rerailing places

C.5 Marking of units

Markings of prEN 15877-1:2010 are required if applicable. The following are always applicable:

- 4.5.2 Gauge marking
- 4.5.3 Vehicle Tare Weight
- 4.5.4 Vehicle load table

- 4.5.5 Sign for length over buffers
- 4.5.12 Table of Maintenance dates
- 4.5.14 Lifting and re-railing signs
- 4.5.23 Distances between end axles and bogie centres
- 4.5.__ Brake weight

C.6 Gauging

The reference contour with which the unit complies with shall be G1 and GI1 determined as defined in 4.2.3.1 of this TSI.

C.7 Unit characteristics for the compatibility with train detection systems

The unit shall be compatible with the train detection systems based on track circuits and based on axle counters as specified in clauses 4.2.3.3.1and 4.2.3.3.2.

C.8 Longitudinal compressive forces

The verification of safe running under longitudinal compressive forces shall be based on EN 15839:2011.

C.9 Brake

The brake system shall be compatible with vehicles equipped with UIC approved brake systems. The brake system of a unit is compatible with the UIC brake system if it fulfils the following requirements:

- The unit shall be equipped with a pneumatic brake pipe with an inner diameter of 32 mm.
- Brake modes have different brake application and release times and specific brake weight percentage.
- Every unit shall be fitted with a brake system having at least brake modes G and P.

The brake modes G and P shall be assessed according to EN15355:2008+A1:2010 and EN 15611:2008+A1:2010 or UIC 540:2006.

- The minimum braking performance for brake-modes G and P shall be in accordance with table C.1:

Table C.1: Minimum braking performance for brake modes G and P

Braking mode	unit type	Command Equipment	Load status	Requirement for running speed at 100km/h		Requirement for running speed at 120km/h	
				Maximum braking distance	**Minimum braking distance**	**Maximum braking distance**	**Minimum braking distance**
Braking mode "P"	All	All	Empty	S_{max} = 480m λ_{min} = 100% (1) a_{min}=0,91m/s^2 (1)	S_{min} = 390m, λ_{max}=125%, (130%)*, a_{max}= 1,15m/s^2	S_{max} = 700m λ_{min} = 100% a_{min} = 0,88m/s^2	S_{min} =580m, λ_{max}= 125%, (130%)*, a_{max}=1,08m/s^2
	"S1"(2)	Changeover (9)	Inter-mediate	S_{max} = 810m λ_{min} = 55% a_{min} = 0,51m/s^2	S_{min}= 390m, λ_{max}= 125%, a_{max} =1,15m/s^2		
			Loaded	S_{max} = 700m λ_{min} = 65 % a_{min} = 0,60m/s^2	S_{min} = Max [(S = 480m, λ_{max}=100%, a_{max}= 0,91m/s^2), (S obtained with a mean retardation force of 16,5 kN per axle)] (5).		
	"S2"(3)	Variable load Relay (10)	Loaded	S_{max} = 700m λ_{min} = 65 % a_{min} = 0,60m/s^2	S_{min} = Max [(S = 480m, λ_{max}=100 %, a_{max} = 0,91m/s^2), (S obtained with a mean retardation force of 16,5 kN per axle)] (6).		
	"SS"(4)	Variable load Relay (10)	Loaded (18t per axle for brake blocks)			S_{max} (8) = Max [S = 700m, λ_{max}=100%, a_{max} = 0,88m/s^2), (S obtained with a mean retardation force of 16kN per axle)] (7).	
Braking mode "G"					There shall be no separate assessment of the braking performance of units in position G. A unit's braked weight in position G is the result of the braked weight in position P (see UIC 544-1)		

*only for two stage load brake (changeover command) and P10 (cast iron blocks with 10 ‰ phosphor)- or LL-brake blocks

(1) "a" = ((Speed (Km/h))/3,6)^2)/(2x(S-((Te)x(Speed (Km/h)/3,6)))), with Te=2sec. Distance calculation EN 14531-1:2005 section 5.11

(2) a unit "S1" is a unit with empty/load device. Maximum load per axle is 22,5 t.

(3) a unit "S2" is a unit with a variable load relay. Maximum load per axle is 22,5 t.

(4) a unit “SS” shall be equipped with a variable load relay. Maximum load per axle is 22,5 t.

(5) The maximum mean retardation force admitted (for running speed at 100km/h) is 18x0,91 = 16,5 kN/axle. This value comes from the maximum braking energy input permitted on a clasp braked wheel with a nominal new diameter in the range of [920 mm; 1 000 mm] during braking (the brake weight shall be limited to 18 tonnes/axle).

(6) The maximum mean retardation force admitted (for running speed at 100km/h) is 18x0,91 = 16,5 kN/axle. This value comes from the maximum braking energy input permitted on a clasp braked wheel with a nominal new diameter in the range of [920 mm; 1 000 mm] during braking (the brake weight shall be limited to 18 tonnes/axle). Usually a unit, with V max = 100 km/h and fitted with a variable relay is designed to obtain λ = 100% up to 14.5 t/axle.

(7) The maximum mean retardation force admitted (for running speed at 120km/h) is 18x0,88 = 16 kN/axle. This value comes from the maximum braking energy input permitted on a clasp braked wheel with a nominal new diameter in the range of [920 mm; 1 000 mm] during braking (the brake weight shall be limited to 18 tonnes). The mass/axle is limited to 20 t/axle and the corresponding λ is 90%. If it is required λ > 100% with mass/axle > 18 t then it is necessary to consider another kind of brake.

(8) λ must not exceed 125%, considering for brake only on wheels (brake blocks), the maximum mean retardation force admitted of 16 kN/axle (for running speed at 120km/h).

(9) Changeover according to EN 15624:2008+A1:2010.

(10) Variable load relay according to EN 15611:2008+A1:2010 in combination with variable load sensing device according to EN 15625:2008+A1:2010.

- If a unit is equipped with a brake system having in addition further brake modes the assessment procedure as described in clause 4.2.4.3.2.1 shall be carried out for these additional brake modes. The brake application time of the P brake mode according to EN15355:2008+A1:2010 and EN 15611:2008+A1:2010 or UIC 540:2006 are also valid for further brake modes.
- The energy storage has to be designed in such way that after a brake application with the maximum brake cylinder pressure and the maximum unit specific brake cylinder stroke at any load state the pressure in the auxiliary reservoir must be at least 0,3 bar more than the brake cylinder pressure without the addition of any further energy.
- The pneumatic energy of the brake system shall not be used for other applications different than those related to braking purposes.
- The pneumatic half coupling:
  - The interface shall be according to UIC 541-1:2003 Appendix D and E or FprEN 15807:2008
  - The opening of the automatic air brake coupling head shall face the left when looking at the end of the vehicle.
  - The opening of the main reservoir coupling head shall face the right when looking at the end of the unit.
  - The end cocks shall be in accordance with EN 14601:2005+A1:2010.

C.10 Parking brake

If a unit is equipped with a parking brake the location shall be:

- On both sides of the unit if it is operated from the ground or
- On a platform, that can be accessed from both sides of the unit

C.11 Environmental conditions

The following requirements are deemed to comply with the range indicated in clause 4.2.5.

- Air reservoir shall be designed for the temperature range of -40°C to +100°C.
- Brake cylinders and brake couplings shall be designed for the temperature range of -40°C to +70°C.
- Hoses for air brakes and air supply shall be specified for the temperatures range -40°C to +70°C.
- The grease for the lubrication of roller bearing shall be specified for ambient temperatures down to -20°C.

C.12 Welding

For welding EN 15085-1-5:2007 apply.

C.13 Track Gauge

The unit shall be compatible with the 1435 mm track gauge.

C.14 Brake thermal capacity

The brake system shall resist a thermal load equivalent to a braking power of 45 kW per wheel for 34 minutes at 70km/h in addition to the requirements set out in clause 4.2.4.3.3.

Brake blocks, listed in the Technical Document 02 (ERA/TD/2009-02/INT) are exempted from these simulations and tests for the nominal wheel diameter D=920mm, the mass per wheel 11,25 t and for the appropriate block configuration used in the unit.

If the design of the unit complies with the following “standard” conditions

- nominal wheel diameter D between 680 mm and 920 mm
- maximum design speed 120 km/h
- brake block force between 5 and 38 kN for K brake block and between 12 and 100 kN for LL brake blocks for single sided brake block configuration.
- brake block force between 2.5 and 19 kN for K brake block and between 6 and 50 kN for LL brake blocks for double side brake block configuration.
- braked mass per wheel between 2.5 and 11.25 t
- the specific ratio between the max. brake energy and the rim volume of the wheel of the unit does not exceed the specific ratio or the brake block listed in

the technical Document 02 (ERA/TD/2009-02/INT) for the nominal wheel diameter D 920mm and the mass per wheel 11,25 t.

and

- the brake block is listed in the Technical Document 02 (ERA/TD/2009-02/INT) for the nominal wheel diameter D 920mm, the mass per wheel 11,25 t and the appropriate block configuration used in the unit

and

- the wheel is according to 6.1.2.3 with the requirements of C.15

the requirements concerning thermal capacity are fulfilled.

If the design of the unit does not meet the “standard” conditions above the wheel shall be tested according to 6.1.2.3 with the requirements of C.15 and the brake block shall be tested by a test bench program defined in accordance with the test bench programs of UIC 541-4:2010 taking into account the maximum brake energy.

C.15 Wheel

The wheels shall be in accordance with EN 13262: 2004+A1:2008 and EN 13979-1:2003 +A1:2009. The thermal mechanical type test required in 6.1.2.3 shall be carried out in accordance with table C.2 when the brake system is acting directly on the wheel tread.

Table C.2:

Wheel diameter range [mm]	**1000 - 920**	**920 - 840**	**840 - 760**	**760 - 680**
Standard power value	50 kW	50 kW	42,5 kW	38 kW
Application time	45 min	45 min	45 min	45 min
Running speed	60 km/h	60 km/h	60 km/h	60 km/h

APPENDIX D STANDARDS OR NORMATIVE DOCUMENTS REFERRED TO IN THIS TSI

TSI		Standard	
Characteristics to be assessed		Mandatory ref Standard N°	Clauses
Structure and mechanical part	**4.2.2**		
Strength of unit	4.2.2.2	EN12663-2:2010	5
		EN 15877-1:2010	4.5.13
Vehicle track interaction and gauging	**4.2.3**		
Gauging	4.2.3.1	EN 15273-2:2009	all
Compatibility with load carrying capacity of lines	4.2.3.2	EN 15528:2008	6.1, 6.2
Axle bearing condition monitoring	4.2.3.4	EN 15437-1:2009	5.1, 5.2
Safety against derailment running on twisted track	4.2.3.5.1	-	-
	6.2.2.1	EN 14363:2005	4.1
		prEN 15839	4.2
Running dynamic behaviour	4.2.3.5.2	EN 14363:2005	5
	6.1.2.2.1	EN 14363:2005	5
		EN 15687:2010	5
		prEN 15827:2009	9.3
Running gear	4.2.3.6	-	-
	6.1.2.2.1	EN 13749:2005	9.2
		CEN TC 256 WI 337:2010	all
Structural design of bogie frame	4.2.3.6.1	EN 13749:2005	9.2
	6.1.2.2.1	EN 13749:2005	9.2

TSI		Standard	
Characteristics to be assessed		Mandatory ref Standard N°	Clauses
Wheelset	4.2.3.6.2	-	-
	6.1.2.2.2	EN13260:2009	3.2.1
Wheel	4.2.3.6.3	-	-
	6.1.2.2.3	EN 13979-1:2003 +A1:2009	7, 6.2
Axle	4.2.3.6.4	-	-
	6.1.2.2.4	EN 13103:2009	7
Brake	**4.2.4**		
In-service brake	4.2.4.3.2.1	EN 14531-6	all
		UIC 544-1	all
Parking brake	4.2.4.3.2.2	EN 14531-6:2009	6
		EN 15877-1:2010	4.5.25
System protection	**4.2.6**		
Fire protection - materials	6.2.2.6.2	EN 13501-1	all
Protection against electric hazard – indirect contact	4.2.6.2.2.1	EN 50153:2002	6.4
Protection against electric hazard – indirect contact	4.2.6.2.2.2	EN 50153:2002	5
Rear end	4.2.6.3	prEN16116-2	6.3.1

Additional voluntary assessment for wagons used under certain operative regimes	**App. C**		
End coupling	C.1	EN 15566:2009	all
		EN 15551:2009	all
		EN 16116:20__	all
Footsteps and handrails	C.2	EN 16116:20__	all
Strength of main vehicle structure and equipment	C.3	EN12663-2:2010	5.1, 8.2.5.1
Marking of units	C.5	EN 15877-1:2010	all
Longitudinal compressive forces	C.8	EN 15839:2011	all
Brake	C.9	EN 14601:2005 +A1:2010	all
		EN 14531-1:2005	5.11
		EN 15355:2008 +A1:2010	all
		EN 15611:2008 +A1:2010	all
		EN 15624:2008 +A1:2010	all
		EN 15625:2008 +A1:2010	all
		prEN 15807:2008	all
		UIC 540:2006	all
		UIC 541-1:2003	all
Welding	C.12	EN 15085-1-5:2007	all
Brake thermal capacity	C.14	UIC 541-4:2010	all
Wheel	C.15	EN 13262: 2004+A1:2008	all
		EN 13979-1:2003 +A1:2009	all

APPENDIX E REAR-END SIGNAL

E.1 Lamps

The colour of tail lamps shall be in accordance with clause 5.5.3 of EN 15153-1:2010, (values).

The lamp shall display a luminous area of at least 170 mm diameter.

The reflector system shall be designed to display a lighting strength of at least 15 candela of red light along the axis of the lighting surface for an angle of opening of 15° horizontally and 5° vertically. The intensity must be at least 7.5 candela of red light.

The lamp shall be suitable to be attached to units using the devices as set out in 4.2.6.3 of this TSI. The lamp shall be equipped with:

- a switch (on/off)
- a warning light which indicates the battery status.

E.2 Reflective plates

The reflective plates shall be suitable to be attached to units using the devices as set out in 4.2.6.3 of this TSI. The reflective section of the plates shall be 150x200 mm as illustrated in figure E.1. The side triangles shall be white, the top and the bottom triangles shall be red. The plate shall be retro-reflective in accordance with EN 12899-1:2007 Class Ref. 2.

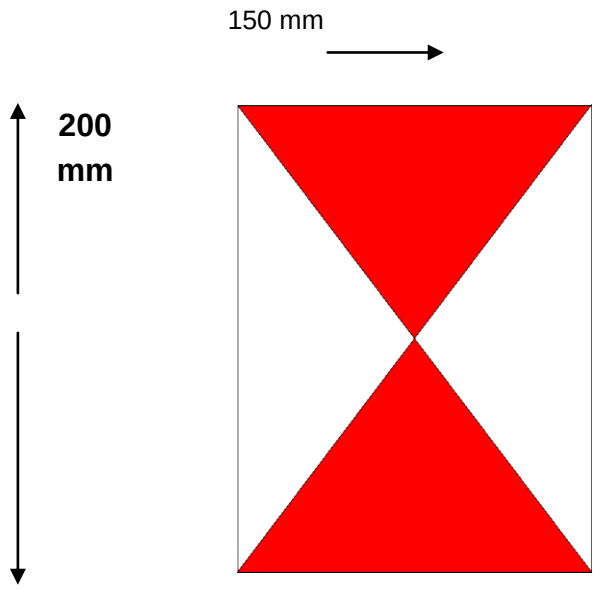

Figure E.1: Reflective plate

APPENDIX F ASSESSMENT ASSIGNED TO THE PRODUCTION PHASES

Table F.1: Assessment assigned to the production phases

Characteristics to be assessed, as specified in clause 4.2		Design and development phase		Production phase	Particular assessment procedure
		Design review	Type Test	Routine Test	
Element of the Rolling Stock sub-system	Clause				Clause
Structure and mechanical part	**4.2.2**				
End coupling	4.2.2.1.1	X	n.a.	n.a.	-
Inner coupling	4.2.2.1.2	X	n.a.	n.a.	-
Strength of unit	4.2.2.2	X	X	n.a.	-
Vehicle track interaction and gauging	**4.2.3**				
Gauging	4.2.3.1	X	n.a.	n.a.	-
Compatibility with load carrying capacity of lines	4.2.3.2	X	X	n.a	-
Compatibility with train detection systems	4.2.3.3	X	X	X	-
Axle bearing condition monitoring	4.2.3.4	X	X	n.a.	-
Safety against derailment running on twisted track	4.2.3.5.1	X	X	n.a.	6.2.2.1
Running dynamic behaviour	4.2.3.5.2	X	X	n.a.	6.1.2.1 / 6.2.2.2
Structural design of bogie frame	4.2.3.6.1	X	X.	n.a.	6.1.2.1
Characteristics of wheelsets	4.2.3.6.2	X	X	X	6.1.2.2
Characteristics of wheels	4.2.3.6.3	X	X	X	6.1.2.3
Characteristics of axles	4.2.3.6.4	X	X	X	6.1.2.4
Axle boxes / bearings	4.2.3.6.5	X	X	X	6.2.2.3
Variable gauge wheelsets	4.2.3.6.6	open	open	open	Open
Brake	**4.2.4**				
Safety requirements	4.2.4.2	X	n.a	n.a	-
Functional and technical requirements	4.2.4.3	X	X	n.a	-
In-service brake	4.2.4.3.2.1	X	X	X	-
Parking brake	4.2.4.3.2.2	X	n.a	n.a	-
Thermal capacity	4.2.4.3.3	X	X	n.a	6.2.2.4
Wheel slide protection (WSP)	4.2.4.3.4	X	X	n.a	-
Environmental conditions	**4.2.5**				
Environmental conditions	4.2.5	X	n.a. /X (1)	n.a.	6.2.2.5
(1) Type test if and as defined by the applicant					
System protection	**4.2.6**				
Fire safety	4.2.6.1	X	X	n.a	6.2.2.6
Protection against electric hazard	4.2.6.2	X	X	n.a	-
Attachment devices for rear end signal	4.2.6.3	X	X	n.a	-